

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Art Unit : 1792  
Examiner : Saeed T. Chaudhry  
Serial No. : 10/538,672  
Filed : June 9, 2005  
Inventors : Peter Asplund  
: Carl-Johan Hjerpe  
Title : METHOD FOR CLEANING A  
: STATIONARY GAS TURBINE  
: UNIT DURING OPERATION

Customer No. 035811

Docket No.: GTE-07-1051US

Confirmation No.: 3692

Dated: March 28, 2008

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**DECLARATION OF THOMAS WAGNER**

1. I am the Technical Director ("TD") of Gas Turbine Efficiency ("GTE"), the assignee of the present application.

2. I have more than 30 years of experience in technology design, development and management in the energy industry. Prior to my employment with GTE, I held a variety of specific gas turbine related technology roles including Manager of Combustion Engineering, Manager of Field Service Engineering, and Manager of Non-Destructive Testing for Gas Turbines. I was also the General Manager of Technology for Wind Energy and General Manager of Technology for Generators.

3. I am familiar with the subject matter described and claimed in the present application, and have reviewed the Response submitted with this declaration.

4. The invention described in the present application has been commercially developed by GTE. The commercial manifestation of the invention is called the GTE-400 washing system.

5. The present application discloses and claims a method and system for cleaning of stationary gas turbine units during operation. As set forth in the Response submitted with this declaration, Claim 8 recites steps performed by the GTE-400 for cleaning. Claim 17 recites additional steps that may be performed by the GTE-400 for cleaning. Claim 23 recites a system based upon the GTE-400 design.

6. Attached hereto as "Exhibit A" is product information for the GTE-400 design.

7. Attached hereto as "Exhibit B" is a letter from Statoil ASA regarding the GTE-400.

8. Attached hereto as "Exhibit C" is a letter from Fortum Oil & Gas regarding the GTE-400.

9. The GTE-400 is a reference design that is included in a product line of water wash systems offered by GTE. See Ex. A. This product line addresses the existing gas turbine size range from smallest to largest as shown by the Product Line Figure. Id.

10. As part of the GTE-400, at least one spray nozzle is positioned at an acceleration duct, which is conventionally known as the bellmouth. The acceleration duct adjoins an inlet of a compressor and has a decreasing cross section in an air flow direction in order to increase the velocity of air moving through the acceleration duct.

11. The GTE-400 operates to clean the turbine units during operation. In general, for cleaning of a gas turbine there are two options, namely on-line washing or off-line washing, which is also known as crank washing. In Off-line washing, the gas turbine is not in operation, i.e. does not burn fuel, but instead is rotated with the aid of the start motor of the gas turbine. In on-line washing, the gas turbine is in normal operation, i.e. while fuel is being burned in the combustion chamber of the gas turbine, and the gas turbine is at operational speeds. As a consequence, with on-line washing, the air flow through the gas turbine unit is at full speed with the turbine fully loaded, and with off-line washing, the air flow through the gas turbine unit has the cranking speed of the turbine, which is typically at approximately 30% of the full speed for many units. In comparing on-line and off-line washing, a major drawback with off-line washing is that the gas turbine must be taken out of operational mode for cleaning, which can have serious impacts on production.

12. Prior to the development of the GTE-400, a long-felt but unresolved need in the turbine industry was the identification of a method to effectively clean the first three (3) to five (5) stages of a compressor while the gas turbine **is in operation**. Prior to the GTE-400, in order to effectively clean the first three (3) to five (5) stages of a compressor, it was required to use off-line water washing, which as noted above has the drawback that the gas turbine is required to be taken out of operation during the cleaning process. Where prior systems were attempted to be used for on-line washing, cleaning of the first three (3) to five (5) stages of the compressor was ineffective, which was attributed in part to the high temperatures of the gas turbine during operation, which typically surpass 100C. In addition, prior to the GTE-400, it was also recognized in the industry that such prior systems used for off-line water wash had limitations as to how clean they would actually make the compressor, which resulted with frequent shutdown of the gas turbines for subsequent cleaning.

13. Prior to the development of the GTE-400, others had tried but failed to make a product similar to the GTE-400 that was suitable for on-line washing. As an example, a company by the name of Statoil ASA ("Statoil"), a large gas turbine operator in Europe, in the late 1990's had a need to obtain more operating time on the gas turbines that were applied on offshore platforms. A key limitation for achieving more hours was the need to periodically shutdown the turbines to conduct off-line water wash. Statoil conducted a global search for technology to enable longer operating periods between compressor off-line water wash. The numerous companies that Statoil contacted had attempted but failed to provide a satisfactory solution. GTE was contacted by Statoil and GTE proposed to develop the system described in the present application which came to be known as the GTE-400. GTE subsequently developed the GTE-400, which utilized an on-line wash process to clean the early compressor stages. Statoil advised that the GTE approach was the only suitable technology identified in its search. See Ex. B. As described in more detail below, through use of the GTE-400, Statoil achieved a 2%

turbine availability improvement due to its ability to employ on-line water wash for its gas turbines, which resulted in millions of dollars of additional production time since the gas turbines could continue to operate during cleaning. Id. These benefits directly resulted in use of the GTE-400 by Statoil across its entire fleet and also use of the GTE-400 by numerous other oil and gas companies, including SNAM from Italy and Hawaiian utility- Kapaia Power Station, Kauai Island Utility. Moreover, Fortum Oil & Gas ("Fortum") also uses the GTE-400. See Ex. A. Fortum has found that the GTE-400 uses less volume of fluid to achieve even better cleaning results. Id. In fact, the improvements for Fortum's turbines have been at least 10% with the GTE-400. Id.

14. In development of the GTE-400, GTE desired to find a design that would work for the aforementioned two water wash conditions; off-line (cranking speed of the turbine ~ 30% of full speed) and on-line (full speed and full load of the turbine).

15. GTE determined that the preferred location for the nozzle(s), in order to achieve a design that would work with off-line and on-line water washing, was in the acceleration duct of the gas turbine. GTE utilized Computational Fluid Dynamic ("CFD") modeling to assess the performance of this design.

16. Based on this CFD analysis, GTE and Statoil conducted a field and laboratory evaluation of the conventional water wash approach as compared to the new GTE approach. The conventional approach was to locate the nozzle in the inlet duct upstream of the compressor, which is commonly referred to as the "low pressure area." The results showed that GTE's new approach of locating the nozzle in the acceleration duct was much more effective at cleaning for both on-line and off-line water washing than the conventional system. See Ex. A. This practice was new to the industry.

17. Prior art systems and methods, which introduced a spray upstream the acceleration duct, produced large differences between the final speeds of spray drops and air after acceleration through an acceleration duct. The difference in speed between the drops and air is known as a "slip speed." A "slip ratio" is defined as the ratio between the drop speed and the air speed, the drop speed constituting numerator and the air speed constituting denominator. The low slip ratio in prior art systems substantially precluded the spray from traveling through compressor stages 3-5 with on-line washing because the drops encounter the blades and guide vanes unfavorably. The GTE-400 solves this problem by locating nozzles in the acceleration duct, which achieve higher slip ratios, for example, which is defined as at least 0.8 in claims 11 and 21 and at least 0.9 in claim 16. This higher slip ratio allows the drops to move through compressor stages 3-5 during on-line washing.

18. Locating a nozzle at the acceleration duct produced unexpected results, as it was realized that compressor performance is maintained for a longer period of time. The attached Exhibit A shows the difference between an off-line wash on an industrial turbine using a conventional system, which as noted above employs a nozzle located in the low pressure area, and the GTE-400. See Ex. A. The use of the GTE-400 for off-line washing recovers greater output power from the gas turbine than the conventional approach; in particular, about 35 3/4 MW for the conventional approach and 36 3/4 MW for the GTE-400. Id. In addition, when the GTE-400 is used for off-line washing, the power level is maintained for about two (2) to four (4) times longer than the conventional approach before another off-line wash is needed (i.e., 3200

hours for the GTE-400 as compared to 800 hours for the conventional approach). Id. Moreover, the power output is maintained at a higher level between off-line washes using the GTE-400, which goes no lower than 35 1/2 MW, as compared to the conventional approach, which drops to a low of slightly less than 33 MW. Id.

19. GTE has achieved much commercial success with its Water Wash Product Line including the GTE-400, which incorporates the novel features described above and claimed in the present application. Gross revenues for 2008 for the GTE Water Wash Product Line are forecast to be \$9 Million, which is approximately 26% of GTE's total revenues.

20. Because of the success of the GTE-400 and the GTE Water Wash Product Line, there are several companies that have recently began to offer products similar to the GTE-400, which contain the novel features described above and claimed in the present application, including RCM, ECT Inc., Dectron Internationale Inc. and AeroWash Inc.

21. The commercial success of the GTE-400 and the overall GTE Water Wash Product Line is directly attributable to the novel features described above and claimed in the application.

I declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under §1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application and any patent issuing thereon.

03-28-08

Date

Thomas Wagner

Thomas Wagner